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Study of Physico- Chemical Parameters of Sugar Industry Effluent

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***Abstract*— *Sugar mill effluents are responsible for deterioration of water quality, due to effluents physical and chemical characteristics of river water changes and become unfit for human consumption. The present study was undertaken on the physico-chemical parameters of Bhima-Patas sugar industry effluent in Daund Tahsil. The study was conducted during 2014-2017 in crushing season of sugar industry. During the study period we recorded the different Physical as well as chemical properties of sugar mill effluent like Temperature, pH, TSS, TDS, Hardness, BOD, COD, DO, SO_4, PO_4, Oil and Grease, Zn, Hg etc. The result from the analysis of sugar industry waste water (effluent) shows that most of the parameters were much higher than the Minimum Pollution Level (MPL). Hence the flow of this effluent into the river causes serious pollution problems for aquatic life as well as human and livestock.*

***Keywords*— Effluent, Pollution, Temperature, pH.**

I. INTRODUCTION

According to survey conducted by NEERI 70% of India' s fresh water is polluted by industrial effluents. Aquatic pollution has resulted in the disintegration of flora and fauna. Types of water pollution may be due to inorganic pollutant, enrichment with phosphate, sulphate, nitrate, trace elements like Hg, Cd, Pb, As, Se, Zn etc. pesticides and fertilizer Philip Weinberg (1992) and Jadhav (1995).

The World Bank has listed sixty-four industries which are highly polluting, distilleries being at the top and sugar industries ranked second. In Maharashtra there are 207 sugar industries which have a crushing capacity of 4.78 lakh metric ton per day. Sugar industry is basically a seasonal industry in nature and operates only 120-210 days in year (Nov-May), a significantly large volume of waste water is generated during production of sugar, which contain high amount of pollution load particularly in terms of TDS, TSS, DO, Organic matter, fresh mud bagasse and air pollutant.

When this effluent discharged and mixed into water bodies, the quality of water and aquatic life get changed. The need for investigation of the sugar factory effluents was concerned by many researchers from India and abroad and has conducted a series of investigations and gave fruitful results. Varma and Shukla (1969) and Essink (1978) have found that the effluent released by sugar industry produced a high degree of organic pollution in the aquatic ecosystem.

According to Coroni (1975) the effluent discharge by sugar industry having high BOD affects the aquatic life due to significant decrease in dissolved oxygen. Pondhe *et al.*, (1982) studied the impact of sugar mill effluents in rivers and ground water and found that the water quality was changed due to mixing of sugar mill effluent. Kudesia and Verma (1985) reported sugar mill effluent contain high BOD and organic matter. Behera and Missra (1985) have found that the sugar mill effluents are disturbing the ecological cycle of living organism in aquatic ecosystem. Kohar *et al.*, (1991) have studied the threat of aquatic life by the effluents of sugar industry. They found that due to depletion of dissolved oxygen in water by the effluents create anoxic condition which is unsuitable for aquatic life. Chauhan (1991) reported that TSS is harmful parameter in the effluent of sugar factory become causative agent for toxicity in the river and ground water in which they get

mixed. Many researchers from India and other countries have under taken studies on sugar mill effluent in their particular area from time to time. No previous published work regards to sugar industrial effluents from same region hence we conducted this study.

II. MATERIAL AND METHODS

Study area:

Study was conducted during 2014 to 2017 from sugar industry Bhima- Patas, Pune during crushing season.

Methodology:

The effluent samples were collected every month during crushing season for the study period at 7 to 8 am in glass jars and analysed as suggested by APHA (2000). Samples were analyzed periodically for physico-chemical characteristics. The temperature of water sample was recorded on the field itself with the help of centigrade thermometer. The pH of effluent and river water measured immediately after collection of the sample. pH of the sample was measured on the digital pH meter using glass electrode by Electrometric method. TDS and TSS were analysed by Gravimetric method. Hardness measured by EDTA Titrimetric method. Biochemical oxygen demand (BOD) was calculated by Titrimetric methods. Chemical oxygen demand (COD) was measured by Redox method. Dissolved Oxygen (DO) was measured by Winkler's iodometric mehod. Phosphate and sulphate were measured by stannous chloride and Turbidimetric methods respectively, Zinc calculated by Zincon method (APHA, 2000), Mercury and Arsenic measured by Colorimetric method (APHA, 2000).

III. RESULT AND DISCUSSION

The effluents of sugar industry have high pollution load mainly in terms of pH, TSS, Total Hardness, COD, BOD, DO and SO_4.Generally amount of wastes water generated in a sugar factory ranges from one thousand to two thousand metric cube per day (Verma & Shukala; 1969). The physico-chemical parameters enable us to understand and estimate pollution level of the effluent on the environment.

The effluent sample was collected from selected sampling station on the main stream of the sugar industry during crushing season i.e. 2014-2015, 2015-2016 and 2016-207. The samples were analyzed in laboratory by the standard methodology of APHA (2000). The following physico-chemical parametric results were obtained in the cluster of sugar industrial effluent and are recorded in table no. 1, 2 and 3 respectively.

Table 1 Physico-chemical values of Sugar Industry effluent during the year 2014-2015

Parameters	Nov 14	Dec 14	Jan 15	Feb 15	Mar 15	Apr 15	Permissible discharge limit (IS:2490)
Temp of Eff (^{0}C)	41	41	42	40	41	42	Not more than 40 ^{0}C
pH	5.70	5.60	4.90	5.20	4.35	4.0	5.5 - 9.0
TSS	260	245	320	266	230	240	100 mg/l
TDS	980	1370	1200	1030	1790	1530	2100 mg/l
Total hardness	270	450	846	981	995	754	200-500
BOD	900	1167	1360	1290	1435	1516	100 mg/l
COD	1675	1979	2455	2310	2540	2569	250 mg/l
DO	NIL	NIL	NIL	NIL	NIL	NIL	_
PO_4	8.0	9.4	10.35	10.0	11.70	11.80	_
SO_4	140	180	210	213	217	260	100 mg/l
Oil & Grease	NIL	NIL	NIL	NIL	NIL	NIL	10 mg/l
Zn	6.9	6.0	6.5	6.3	7.0	7.5	1 5 mg/l
Hg	NIL	NIL	NIL	NIL	NIL	NIL	0.01 mg/l
As	0.013	0.015	0.024	0.015	0.02	0.024	0.2mg/l

(All the values are in mg^{-L} except Temp. and pH.)

Table 2 Physico-chemical values of Sugar Industry effluent during the year 2015-2016

Parameters	Nov 15	Dec 15	Jan 16	Feb 16	Mar 16	Apr 16	May 16	Permissible discharge limit (IS:2490)
Temp of Eff (^{0}C)	40	40.5	40.5	42.5	43	44.5	46.5	Not more than 40 ^{0}C
pH	6.8	5.9	5.6	4.1	4.4	4.3	3.7	5.5 - 9.0
TSS	105	125	145	180	260	390	340	100 mg/l
TDS	450	645	680	776	620	610	995	2100 mg/l
Total hardness	327	383	655	752	990	830	860	200-500
BOD	1020	1200	1430	1890	1950	2960	4650	100 mg/l
COD	2000	2340	2630	3560	3735	4220	7800	250 mg/l
DO	NIL	NIL	NIL	NIL	NIL	NIL	NIL	_
PO_4	6.38	7.40	7.60	11.20	11.50	12.10	13.0	_
SO_4	90	157	225	340	380	320	310	100 mg/l
Oil & Grease	NIL	NIL	NIL	NIL	NIL	NIL	NIL	10 mg/l
Zn	5	5	5.5	6	6.5	7	8	1 5 mg/l
Hg	NIL	NIL	NIL	NIL	NIL	NIL	NIL	0.01 mg/l
As	0.015	0.020	0.02	0.025	0.030	0.035	0.040	0.2mg/l

(All the values are in mg^{-L} except Temp and pH.)

Table 3 Physico-chemical values of Sugar Industry effluent during the year 2016-2017

Parameters	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	Permissible discharge limit (IS:2490)
Temp of Eff (^{0}C)	40	41.5	41	43	44	45	Not more than 40 ^{0}C
pH	5.0	4.8	4.8	4.3	4.1	4.0	5.5 - 9.0
TSS	100	110	170	185	195	215	100 mg/l
TDS	500	515	650	670	585	610	2100 mg/l
Total hardness	345	440	475	600	590	660	200-500
BOD	1010	1070	1200	1390	1740	1800	100 mg/l
COD	1420	1615	1880	2135	3035	3250	250 mg/l
DO	NIL	NIL	NIL	NIL	NIL	NIL	_
PO_4	6.6	7.5	8.5	9.0	9.0	10.	_
SO_4	110	140	180	205	230	245	100 mg/l
Oil & Grease	NIL	NIL	NIL	NIL	NIL	NIL	10 mg/l
Zn	2.5	3.5	4.2	6.0	5	5.6	1 5 mg/l
Hg	NIL	NIL	NIL	NIL	NIL	NIL	0.01 mg/l
As	0.019	0.018	0.020	0.026	0.029	0.024	0.2mg/l

(All the values are in mg^{-L} except Temp and pH.)

Temperature: -

Temperature is the primary environmental factor that affects the biological activities and solubility of gases. The mean values of temperature of the effluent ranged from 40-42^{0}C, 40-46.5^{0}C and 40-45^{0}C during 2014-2015, 2015-2016 and 2016-2017 respectively, the highest temperature was recorded 46.5^{0}C in May 2016 & lowest 40^{0}C in Nov 2015. (Table No.2). High values of temperature show the presence of fewer amounts of dissolved gases, which make water tasteless and less palatable (Trivedy et al., 1986).

pH:-

The mean values of pH of the effluent ranged from 4.0-5.7, 3.7-6.8 and 4.0-5.0 during 2014-2015, 2015-2016 and 2016-2017 respectively. pH was found lowest 3.7 during May 2016 and it was higher 6.8 in Nov 2015. (Table No. 2). pH of water is proved to be important ecological factor which controls the activities and distribution of aquatic flora and fauna (Verma & Shukla 1978). The alteration in pH of water is accompanied by changes in physico-chemical aspects of the medium. pH of medium changes due to human activities in and around it (Zutshi *et al.*, 1973) and (Singh, 1986).

Total suspended solids (TSS):-

TSS is more harmful parameters in the effluents of sugar industry. They cause toxicity in the river and ground water in which they get mixed (Chauhan, 1991). The values of TSS of sugar industry effluents ranging from 230-320mg/l, 105-390 mg/l and 100-215 mg/l during the crushing seasons 20014-2014, 2015-2016 and 2016-2017. The highest TSS was recorded at 390 mg/l during April 2016 and lowest 100 mg/l in Nov 2016. (Table no.2 &3)

Total dissolved solids (TDS):-

Effluents of sugar factory contain appreciable amount of total dissolved solids. It includes salts of variety of organic substance. The dissolved solids normally confer a degree of hardness to water. A value of TDS was found in the effluent ranging from 980-1790 mg/l, 450-995 mg/l and 500-670 mg/l during 2014-2015, 2015-2016, and 2016-2017 respectively. The highest TDS was recorded 1790 mg/l during March 2015 and lowest 450 mg/l in Nov 2015. (Table No.1 and 2). Effluent having high TDS is harmful for irrigation and disposal on land, high amount of solids in the effluents increase their toxicity as they do not support any life them (Maid and Shimpi, 1984).

Total hardness: -

The values of Total hardness of the effluent were recorded ranging from 270-995 mg/l., 327-990 mg/l and 345-660 mg/l during 2014-2015, 2015-2016 and 2016-2017 respectively, the highest total hardness was recorded 995 mg/l during March 2015 and lowest 270 mg/l in November 2014. (Table No.1)

Bio-chemical oxygen demand (BOD): -

BOD of the effluents increases with temperature and decreases as the sedimentation of waste take place (Baruach*et al;* 1993). BOD values decrease as the effluent flow longer distances (Avash Maruthi, 2000). BOD is an important parameter which shows the level of biological pollution of the effluents. The mean values of BOD of the sample were collected have been recorded in tables and found ranging 900-1516 mg/l, 1020-4650 mg/l, 1010-1800 mg/l during 2014-2015, 2015-2016 and 2016-2017 respectively. BOD was maximum 4650 mg/l during May 2016 and lowest 900 mg/l in Nov 2014. (Table No.2 & 1)

Chemical oxygen demand (COD): -

High COD can result into infertile of soil due to lowering of the amount of carbon, nitrogen and phosphorous (Trivedi and Shinde, 1983). Effluents with high COD cause toxic effects on aquatic biota (Chauhan, 1991). The COD values found ranging 1675-2570 mg/l during 2014-2015 & 2000-7800 mg/l during 2015-2016 and 1420-3250 mg/l during 2016-2017. COD was found highest 7800 mg/l during May 2016 and lowest 1675 mg/l in Nov 2014. (Table no.2 &1)

Dissolved oxygen (DO):-

Dissolved oxygen is one of the most important parameters in determining water quality. The existence of aquatic life depends upon concentration of oxygen in water. The value of dissolved oxygen in the sample collected is almost zero. It is also noticed that dissolved oxygen was decrease with increase in temperature and contamination of organic matter.

Phosphate and Sulphate (PO_4 and SO_4):-

The value of Phosphate in the effluent was found in the range 8.0-11.80 mg/l, 6.38-13 mg/l and 6.6-10 mg/l during 2014-2015, 2015-2016, 2016-2017 respectively.

The maximum value of phosphate 13 mg/l was recorded in May 2016 & minimum (6.38 mg/l) was found in Nov 2015. (Table No.1&2)

Sulphate content in the effluents ranged 140-260 mg/l during 2014-2015, 90-380 mg/l in 2015-2016 and 110-245 mg/l during 2016-2017. The maximum value of sulphate 380 mg/l was recorded in March 2016 & minimum 90 was found in Nov 2015 (Table No.2). Wetzel (1975) concluded that phosphorus was most important factor bringing about eutrophication and algal growth, each phosphorus molecule promotes the incorporation of 7

molecules of nitrogen and 40 molecules of carbon dioxide in aquatic algae.

Oil &grease: -

Oil and grease were not reported in the effluent sample of sugar industry for the three crushing seasons studied. Oil and grease are used for smooth operations of mill and other parts. Its value is high when the operation is defective.

Heavy Metals: Zinc, Mercury and Arsenic (Zn, Hg and As)

The amount of Zinc (Zn) in the effluents was found 6.0-7.5 mg/l during 2014-2015 and 5.0-8.0 mg/l during 2015-2016 and 2.5-6.0 mg/l during 2016-2017.The maximum value of Zinc 8 mg/l was recorded in May 2016& minimum 2.5 mg/l was found in Nov 2016. (Table No. 2 & 3).

Whereas Mercury (Hg) in the effluent was found nil and Arsenic (As) in the effluents was 0.013- 0.024 mg/l during 2014-2015 and 0.015-0.040 mg/l during 2015-2016 and 0.019-0.024 mg/l during 2016-2017.The maximum value of Arsenic 0.040 mg/l was recorded in May 2016 & minimum 0.013 mg/l was found in Nov 2014.(Table No.2 & 1). Ajmal *et.al,* (1985) recorded that the heavy metal concentrations in the water depend on the pH of the system. Metzner (1977) studied fate of copper and zinc at different pH in waste waters and found that solubility of these metals was inversely proportional to the system and higher solubility found at pH 7 or below.

REFERENCES

[1] Ajaml, M. Khan, M. A. and Nomani, A. A. (1985): Distribution of heavy metals in water and sediments of selected sites of Yamuna river (India). *Environ monit Assess* 5:205-224.

[2] APHA (2000): Standard methods for the examination of water and west water 18th Edition,American Public Health Association, American water works Association and Water Pollution Control Federation,Washington.

[3] Arindam Kumar, (1998): physico-chemical characteristic at Chukia sugar mill effluent. Advances in plant science. 11(2) 63-68.

[4] Avash Maruti, Y. and S. Ramakrishna Rao(2000): Effect of sugar mill effluent of organic reserves of fish. *Pollution Research* 19(3):391-395.

[5] Baruach A. K., Sharma R. N. and Borah G.G. (1993): Impact of sugar mill and distillery effluents on water quality of river Colabil Asam. Indian Journal of Environmental Health 35(4)288-293.

[6] Beher B. K. and B.N. Missra (1985): Effect of the sugar mill effluent on the enzyme activity of rice seedling. Ind. Res. 37:390-398.

[7] Chandrasekar, N., Subamami, A. and Saravan, S. (1998): Effect of Sugar Mill Effluent On Germination and Early Seedling Growth of Black Gram. *Journal of Industrial Pollution Control*. 73-78.

[8] Chauhan Anil (1991): Effect of distillery effluent on river Wainganga. Indian Journal of Health 33: 203-207.

[9] Coroni (1975): Seminar on Environmental management July 21, 1999, abstract no.32.

[10] Das S. M. (1989): Aquatic pollution and fisheries in India P-43-50. In (Khulbe R. D. edited) perspectives in aquatic biology. Papyrus publishing house, New Delhi.

[11] Donic, A. (1998): protection of environment through action on the process of production. Gazeta cukrownicza. 106 (12): 234-235.

[12] Essink, K. (1978): the effect of pollution by organic on macrofauna in the eastern dutch wadden sea pub. Neth Snst. Sea. Re, 1: 85-127.

[13] Jadhav H. V. (1995): Environmental pollution. Himalaya publishing house. New delhi 5-22.

[14] Kohar S. K., Ghosh T. K. and Dey M. (1991): Management of complex pollution +9problems Indian reservoirs. Environ. Eco. 9 (2): 460-472.

[15] Kudesia V. P. and Verma S.P. (1985): physico-chemical studies on industrial pollution of Kali Nadi to combined effluents of cane sugare, chemical industry, distillery and rubber industries in Meerut region. Paper presented in IInd International Conference on Envioronmental Education held at New Dehli from March 4-9 Abs. No. 50.

[16] Metzner, A. V. (1977): Removing soluble metals from waste waters, *Wat-Sewage-Works.* 124:98-101.

[17] Obaya, Ramos, Valdes, Garcia, Leon, 1997. Consideration On Applying The Technique of Rapid Infiltration For TeriaryTreatment of Sugar Factory Effluent. Revista ICIDCA Sobre los Derivados de la cane de Azucar 1993 received. 27(1) 22-34.

[18] Philip Weinberg (1992): Public transporation and clean air – Natural allies in ; The environment global problems, local solution. (Eds) James E Hickey et al. Greenwood press, London.

[19] Polpraset, C. (1982): Heavy metals pollution in Chophraya river Eustuary, Thailand. *Water research.* 16:775-784.

[20] Pondhe G. M., Pawar N. J. and Ptial S. F. (1982): Contamination of ground water from sugar mill effluent in joining area of Ahmednagar.(M. S.) National sym. BARC Bombay 202-224.

[21] Pondhe G. M., Pawar N. J. and Ptial S. F. (1982): Contamination of ground water from sugar mill effluent in joining area of Ahmednagar. (M. S.) National sym. BARC Bombay 202-224.

[22] Senthil Kumar R. D, Narayan Swamy, K. Ramkrishnan (2001): Pollution studies on sugar mill effluent. Pollution research 20 (1) 93-97.

[23] Shinha, S.K. (1993): Physico-Chemical Characteristics of Effluent Discharged from Lohat Sugar Factory in Bihar. Environment and Ecology.11 (2):265-268.

[24] Singh, R. (1986): Cultural Impact on Fish Fauna of Rawalsar Lake Himachal Pradesh, *Uttar Pradesh. J.Zoo*.6:1.

[25] Srivastava Kiran, Srivastava K.N. and Sinha A.K. (1995): Impact of sugar factory effluents on physico-chemical and biological characteristics of river Sai at Raebareli-A case study. *Proc. of the IV National Symposium of Envioronment.feb.7-10.39-40*

[26] Trivedy, R.K. and Goel, P.K. (1986): Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad. 11-12

[27] Trivedy, R.K. and Goel, P.K. (1986): Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad. 11-12

[28] Trivedy, R.K. and Shinde, D.B. (1983): Effect of Distillery Waste Irrigation on Soil Characteristics. Poll. Res. Vol.2(2):71-76.

[29] Varma S. R. and Shukla G. R. (1969): Pollution in a perennial stream khalla by the sugar factory effluent near Lashkar district. Saharanpur (U.P.) Ind J. E.Helth.

[30] Voznaya, N.F. (1981): Chemistry of Water and Microbiology. Mir Publishers, Moscow

[31] Wetzel, R.G. (1975): Limnology. Saunders, Philadelphia, U.S.A.

[32] Zutschi, D.P. and Vass, K.K. (1973): Limnological Studies of Dal Lake, Chemical Features. Indian J.Eco.5(1): 90-97